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Table 19

EXTRACTION AREA LOCATIONS & PUMPING RATES FOR EXTRACTION SCENARIO NO. 7

Extraction Area	Model Cell (x,y,z)	Screen Interval (ft)	Approximate Location	Pumping Rate (gpm)
Downgradient Edge of Newmark Plume				
8	(31,39,2)	20 to 580	on Arrowhead Ave.; 150' S/of 14th St.	2000
9	(32,39,2)	-65 to 620	200' E/of Mt. View Ave.; 300' N/of Wabash St.	2000
10	(33,39,2)	20 to 650	250' E/of Sierra Way; on 14th St.	3000
Newmark wellfield of Newmark Plume				
Newmark 1[a]	(23,18,1)	995 to 1248[d]	NE corner of A St. & Western Ave.	0 to 2910[b]
Newmark 2[a]			175' S/of Reservoir Dr.; 40' W/of Magnolia Dr.	
Newmark 3[a]			95' N/of 42nd St.; 280' E/of Western Ave.	
Newmark 4[a]	(23,17,1)	1025 to 1270[d]	65' S/of Reservoir Dr.; 50' E/of Western Ave.	0 to 1585[c]
5	(23,19,1)	995 to 1265[d]	450' W/of 4th St.; 500' S/of 42nd St.	100
Middle Area of Newmark Plume				
14	(33,22,1)	995 to 1216[d]	150' E/of Sierra Way; 200' N/of Ralston Ave.	2000
15	(32,23,1)	1030 to 1190[d]	100' E/of Mt. View Ave.; 200' S/of 39th St.	2000

Note: Extraction area nos. 6 & 12 were eliminated after Run 30A0609.
Extraction area nos. 2 & 6 were eliminated after Run 34C0721

a Existing water-supply well.
b Total pumping rate range for Newmark 1,2 & 3 for 1986 through 1990 was used in the 5-year simulation.
c Pumping rate range for Newmark 4 for 1986 through 1990 was used in the 5-year simulation.
d Initial head in layer 1 (upper aquifer). The screen interval for layer 1 equals the head value minus the bottom elevation for layer 1.

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Table 20

IMAGINARY PARTICLE LOCATIONS FOR EXTRACTION SCENARIO NO. 7

Particle(s)	Model Cell (x,y,z)	Particle(s)	Model Cell (x,y,z)
1	(31,26,1)	35	(35,24,1)
2	(36,26,1)	36	(35,23,1)
3	(36,27,1)	37	(35,22,1)
4	(36,28,1)	38	(34,21,1)
5	(36,29,1)	39	(33,20,1)
6	(36,30,1)	40	(32,19,1)
7	(36,30,2)	41	(31,19,1)
8	(35,31,1)	42	(30,18,1)
9	(35,31,2)	43	(29,18,1)
10	(35,32,1)	44	(28,17,1)
11	(35,32,2)	45	(27,17,1)
12	(35,33,2)	46	(26,17,1)
13	(35,34,2)	47	(25,17,1)
14	(35,35,2)	48	(24,17,1)
15	(35,36,2)	49	(23,17,1)
16	(34,37,2)	50	(22,17,1)
17	(33,38,2)	51	(21,17,1)
18	(32,38,2)	52	(21,18,1)
19	(31,38,2)	53	(21,19,1)
20	(30,37,2)	54	(21,20,1)
21	(30,36,2)	55	(22,20,1)
22	(29,35,2)	56	(23,20,1)
23	(29,34,2)	57	(24,21,1)
24	(29,33,2)	58	(25,22,1)
25	(29,32,1)	59	(26,22,1)
26	(29,32,2)	60	(27,22,1)
27	(29,31,1)	61	(28,22,1)

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Table 20 (Cont'd.)

IMAGINARY PARTICLE LOCATIONS FOR EXTRACTION SCENARIO NO. 7

Particle(s)	Model Cell (x,y,z)	Particle(s)	Model Cell (x,y,z)
28	(29,31,2)	62	(29,22,1)
29	(29,30,1)	63	(30,22,1)
30	(29,30,2)	64	(31,22,1)
31	(29,29,1)	65	(32,22,1)
32	(30,28,1)	66	(32,23,1)
33	(30,27,1)	67	(32,24,1)
34	(36,25,1)	68	(31,25,1)

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Table 21

INPUT AND OUTPUT FILES FOR EXTRACTION SCENARIO NO. 7

Run No.	Rootname Modification	Date	Extension	Filename	Type of File
36	B	07/26/92	BAS	34B0626.BAS	MODFLOW input file
36	B	07/26/92	BCF	34B0626.BCF	MODFLOW input file
36	B	07/26/92	OC	34B0626.OC	MODFLOW input file
36	B	07/26/92	PCG	34B0626.PCG	MODFLOW input file
36	B	07/26/92	RIV	34B0626.RIV	MODFLOW input file
36	B	07/26/92	WEL	34B0626.WEL	MODFLOW input file
36	B	07/26/92	GHB	34B0626.GHB	MODFLOW input file
36	B	07/26/92	EVT	34B0626.EVT	MODFLOW input file
36	B	07/26/92	BCF	34BCELL.BCF	MODFLOW cell-by-cell flow file
36	B	07/26/92	RIV	34BCELL.RIV	MODFLOW cell-by-cell flow file
36	B	07/26/92	WEL	34BCELL.WEL	MODFLOW cell-by-cell flow file
36	B	07/26/92	GHB	34BCELL.GHB	MODFLOW cell-by-cell flow file
36	B	07/26/92	EVT	34BCELL.EVT	MODFLOW cell-by-cell flow file
36	B	07/26/92	OUT	34B0626.OUT	MODFLOW output file
36	B	07/26/92	UFM	34BHEAD.UFM	MODFLOW unformatted head file
36	B	07/26/92	INP	34BPATH.INP	PATH3D input file
36	B	07/26/92	OUT	34BPATH.OUT	PATH3D output file
36	B	07/26/92	DAT	P3DCNFG.DAT	PATH3D data file
36	B	07/26/92	DAT	P3DPLOT.DAT	PATH3D data file
36	B	07/26/92	DAT	P3DFRONT.DAT	PATH3D data file
36	B	07/26/92	DAT	P3DCAPT.DAT	PATH3D data file
36	B	07/26/92	DAT	FRONTXYZ.DAT	PATH3D data file used with SURFER
36	B	07/26/92	DAT	PATHXYZ.DAT	PATH3D data file used with SURFER
36	B	07/26/92	BLN	PATHXY.BLN	PATH3D data file used with SURFER
36	B	07/26/92	BLN	PATHXZ.BLN	PATH3D data file used with SURFER
36	B	07/26/92	BLN	PATHYZ.BLN	PATH3D data file used with SURFER
36	B	07/26/92	GRD	34BCNTR1.GRD	SURFER grid file of head contours
36	B	07/26/92	GRD	34BCNTR2.GRD	SURFER grid file of head contours
36	B	07/26/92	PLT	34BCNTR1.PLT	SURFER plot file of head contours

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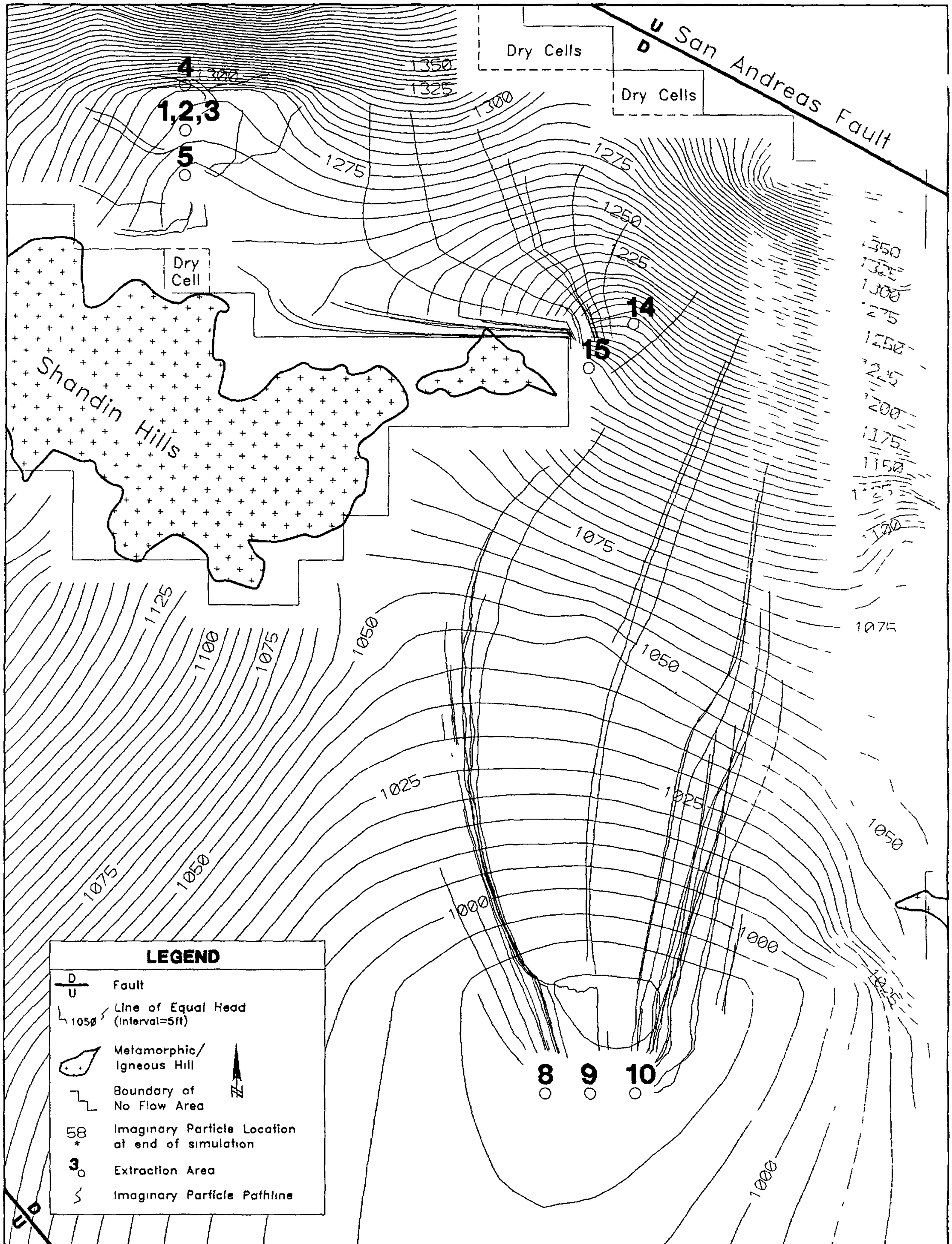
Table 21 (Cont'd.)

INPUT AND OUTPUT FILES FOR EXTRACTION SCENARIO NO. 7

Rootname Run No.	Modification	Date	Extension	Filename	Type of File
36	B	07/26/92	PLT	34BCNTR2.PLT	SURFER plot file of head contours
36	B	07/26/92	DAT	XTRWL36B.DAT	Data file containing locations of extraction wells



URS CONSULTANTS
2710 GATEWAY OAKS DR
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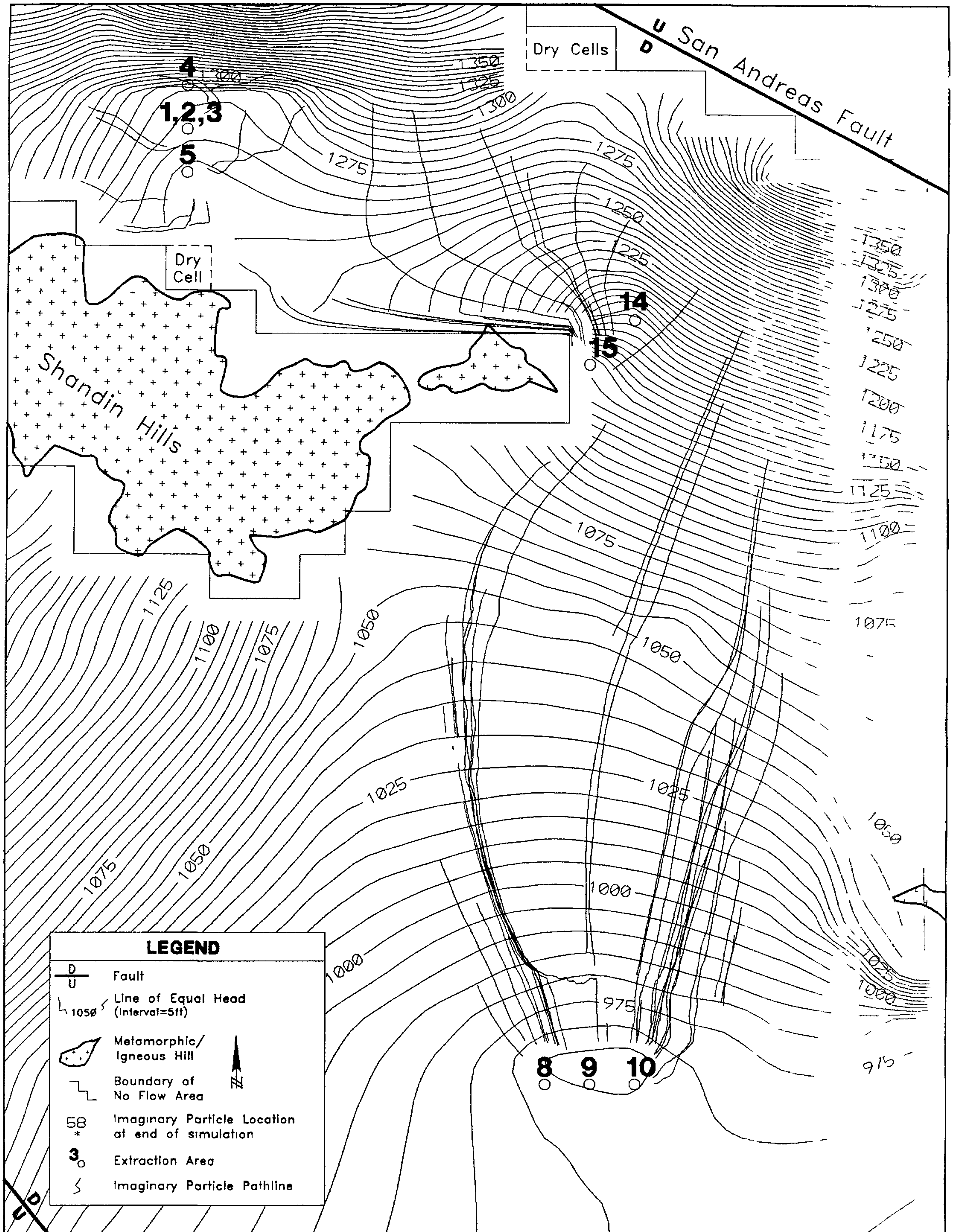
NEWMARK GROUNDWATER SUPERFUND SITE NEWMARK OPERABLE UNIT RI/FS REPORT
ARCS EPA REGIONS IX & X WA NO 54-10 9LJ6

FIGURE 14
HEAD CONTOUR AND PATHLINE PLOT OF EXTRACTION SCENARIO NO 7, LAYER 1 (UPPER AQUIFER)

0 1000 2000
SCALE IN FEET



URS CONSULTANTS 2710 GATEWAY OAKS DR SUITE 250 NORTH SACRAMENTO, CA 95834 (916) 929 2346

NEWMARK GROUNDWATER SUPERFUND SITE NEWMARK OPERABLE UNIT RI/FS REPORT

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FIGURE 15
HEAD CONTOUR AND PATHLINE PLOT OF EXTRACTION SCENARIO NO 7, LAYER 2 (LOWER AQUIFER)

0 1000 2000
SCALE IN FEET

- All 68 imaginary particles that were place along the outer perimeter of the Newmark plume were captured. The extraction areas located in the Newmark wellfield captured all the upgradient imaginary particles and four imaginary particles located just downgradient to the Newmark wells (this is the same capture zone produced in extraction scenario no. 6). Based on the pathlines of these imaginary particles, the extraction areas located in the Newmark wellfield form a complete capture zone of the portion of the Newmark plume originating upgradient (west and northwest) of the Newmark wellfield;

  The two extraction areas located in the middle area of the Newmark plume captured all the upgradient imaginary particles that were not captured by the extraction areas in the Newmark wellfield. The two extraction areas located in the middle area also captured one downgradient imaginary particle;

  A majority of the imaginary particles (44 out of 68) migrated downgradient and were predominantly captured by the three extraction areas located just outside the outer perimeter of the downgradient edge of the Newmark plume. However, ten of the remaining 44 imaginary particles were captured by existing water-supply wells located within the lower two-thirds of the Newmark plume. These existing water-supply wells that influence the Newmark plume will be described in Section 12.0;

- The number, locations, and pumping rates for the extraction areas located at the downgradient edge of the Newmark plume and in the Newmark wellfield were refined in extraction scenarios no. 5 and 6, respectively. The number, locations, and pumping rates determined for the two extraction areas placed at the middle area of the Newmark plume were determined in extraction scenario no. 3. The number, locations, and pumping rates determined for the extraction areas in these three extraction regions were combined to produce extraction scenario no. 7;

- Individual capture zones of sufficient size were produced for the Newmark wellfield and the middle area of the Newmark plume. The simulation of these capture zones did not cause any cells to go dry;

- For the downgradient edge of the Newmark plume extended approximately 1.5 miles downgradient from the Newmark plume edge. However, the capture zone produced for layer 2 (lower aquifer) was the appropriate size. However, the number, locations and pumping rates for the extraction areas used in this extraction scenario were maintained because TCE and PCE were concentrated in layer 2.

11.0 EXTRACTION SCENARIO NO. 8

11.1 Objectives

The objectives for extraction scenario no. 8 were:

- Refine the number, locations, and pumping rates of extraction areas (used in extraction scenarios no. 2 and 5) required to capture the downgradient edge and Newmark wellfield of the Newmark plume;

- Avoid creation of dry cells in the model area during the simulation; and

- Minimize extraction of uncontaminated groundwater.

11.2 Procedure and Data

One simulation was made before the optimum simulation (Run 39B0724) was achieved for extraction scenario no. 8. The procedure described below was followed for achieving optimum Run 39B0724:

- Run 39B0724 was made using MODFLOW that ran for a time span of 35 years. The transient-state flow model, simulated and calibrated for the time period between January 1986 to December 1990, was used as the basis for Run 39B0724. The input data (including the well pumpage) and boundary conditions, used in the calibration of the transient-state flow model, were applied to Run 39B0724 for the first five years of the simulation and repeated in 5-year intervals for 30 additional years. The input data and boundary conditions are described in more detail in Section 3.0;

- A total of four extraction areas were added to the well input file for remediation of the downgradient edge and the Newmark wellfield of the Newmark plume. Three of the extraction areas were located along the centerline of the lower portion of the Newmark plume. The locations of these extraction areas were the same as the locations of extraction area nos. 16 through 18 used in extraction scenario no 4.

  The fourth extraction area was located in the Newmark wellfield of the Newmark plume. This fourth extraction well, and the four existing Newmark wells (same extraction area locations described in extraction scenario no. 2), were used to remediate the Newmark wellfield of the Newmark plume. The four existing Newmark wells were pumped at their normal rates from January 1986 through December 1990. The additional extraction area was added approximately 820 feet south of the Newmark wells and was pumped at 800 gpm for 35 years.

  Due to a limitation in the MODFLOW program, extraction of groundwater from the project flow model was not restricted to separate zones within each model layer. Therefore, all three centerline extraction areas were screened throughout layer 2 and all five extraction areas for the Newmark area were screened throughout layer 1. For layer 1 of the project flow model, the screen interval equaled the head value minus the bottom elevation for layer 1. The screen interval for layer 1 changed when the head in layer 1 changed during the simulation. Table 22 gives the locations of the extraction areas, their pumping rates, and screen intervals used in the simulation;

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Table 22

EXTRACTION AREA LOCATIONS & PUMPING RATES FOR EXTRACTION SCENARIO NO. 8

<table>
<tr><th>Extraction Area</th><th>Model Cell (x,y,z)</th><th>Screen Interval (ft)</th><th>Approximate Location</th><th>Pumping Rate (gpm)</th></tr>
<tr><td colspan="5">Centerline of Newmark Plume</td></tr>
<tr><td>16</td><td>(32,36,2)</td><td>160 to 650</td><td>100' E/of Mt. View Ave.; 250' N/of 18th St.</td><td>4000</td></tr>
<tr><td>17</td><td>(32,34,2)</td><td>260 to 650</td><td>100' E/of Mt. View Ave.; 200' N/of Highland Ave.</td><td>3000</td></tr>
<tr><td>18</td><td>(32,32,2)</td><td>370 to 690</td><td>on Mt. View Ave.; 150' N/of 27th St.</td><td>3000</td></tr>
<tr><td colspan="5">Newmark wellfield of Newmark Plume</td></tr>
<tr><td>Newmark 1[a]</td><td rowspan="3">(23,18,1)</td><td rowspan="3">995 to 1248[d]</td><td>NE corner of A St. & Western Ave.</td><td rowspan="3">0 to 2910[b]</td></tr>
<tr><td>Newmark 2[a]</td><td>175' S/of Reservoir Dr.; 40' W/of Magnolia Dr.</td></tr>
<tr><td>Newmark 3[a]</td><td>95' N/of 42nd St.; 280' E/of Western Ave.</td></tr>
<tr><td>Newmark 4[a]</td><td>(23,17,1)</td><td>1025 to 1270[d]</td><td>65' S/of Reservoir Dr.; 50' E/of Western Ave.</td><td>0 to 1585[c]</td></tr>
<tr><td>5</td><td>(23,19,1)</td><td>995 to 1265[d]</td><td>450' W/of 4th St.; 500' S/of 42nd St.</td><td>100</td></tr>
</table>

Note: Centerline extraction area nos. 19 & 20 for were eliminated after Run 39A0723.

[a] Existing water-supply well.

[b] Total pumping rate range for Newmark 1,2 & 3 for 1986 through 1990 was used in the 5-year simulation.

[c] Pumping rate range for Newmark 4 for 1986 through 1990 was used in the 5-year simulation.

[d] Initial head in layer 1 (upper aquifer). The screen interval for layer 1 equals the head value minus the bottom elevation for layer 1.

- PATH3D was applied to MODFLOW input data, output and the unformatted head files for Run 39B0724. A grid file of the heads was created through the application of PATH3D. Also, pathlines were created for 68 imaginary particles. Sixty-eight imaginary particles were placed along the outer perimeter of the Newmark plume, from upgradient of the Newmark wellfield to the downgradient edge of the Newmark plume. Table 23 gives the locations of the imaginary particles; and

- SURFER was used to produce plots of the head contours and pathlines created during the application of PATH3D.

Results and Summary

The head contour plots for layers 1 and 2 (39BCNTR1.PLT and 39BCNTR2.PLT), and the PATH3D output file for Run 39B0724, were analyzed. Figures 16 and 17 display the head contour plots for layers 1 and 2, respectively. These figures also display the extraction areas and imaginary particles with their pathlines. Table 24 lists the MODFLOW, PATH3D and SURFER files associated with Run 36B0726. The results and summary of the analysis are listed below:

- Initially in Run 39A0723, five extraction areas were used along the centerline of the lower portion of the Newmark plume, at the same locations used in extraction scenario no. 4. No extraction areas were used in the Newmark wellfield;

  The five extraction areas were arranged in a north/south lineament and were spaced approximately 820 feet apart from one another. Extraction area no. 16 was located approximately 1600 feet north of the downgradient edge of the Newmark plume and extraction area no. 20 was located in the center of the Newmark plume, adjacent to the southeast edge of Shandin Hills. Extraction area nos. 17, 18 and 19 were placed between extraction area nos. 16 and 20 using 820 feet spacing.

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Table 23

IMAGINARY PARTICLE LOCATIONS FOR EXTRACTION SCENARIO NO. 8

Particle(s)	Model Cell (x,y,z)	Particle(s)	Model Cell (x,y,z)
1	(31,26,1)	35	(35,24,1)
2	(36,26,1)	36	(35,23,1)
3	(36,27,1)	37	(35,22,1)
4	(36,28,1)	38	(34,21,1)
5	(36,29,1)	39	(33,20,1)
6	(36,30,1)	40	(32,19,1)
7	(36,30,2)	41	(31,19,1)
8	(35,31,1)	42	(30,18,1)
9	(35,31,2)	43	(29,18,1)
10	(35,32,1)	44	(28,17,1)
11	(35,32,2)	45	(27,17,1)
12	(35,33,2)	46	(26,17,1)
13	(35,34,2)	47	(25,17,1)
14	(35,35,2)	48	(24,17,1)
15	(35,36,2)	49	(23,17,1)
16	(34,37,2)	50	(22,17,1)
17	(33,38,2)	51	(21,17,1)
18	(32,38,2)	52	(21,18,1)
19	(31,38,2)	53	(21,19,1)
20	(30,37,2)	54	(21,20,1)
21	(30,36,2)	55	(22,20,1)
22	(29,35,2)	56	(23,20,1)
23	(29,34,2)	57	(24,21,1)
24	(29,33,2)	58	(25,22,1)
25	(29,32,1)	59	(26,22,1)
26	(29,32,2)	60	(27,22,1)
27	(29,31,1)	61	(28,22,1)
28	(29,31,2)	62	(29,22,1)
29	(29,30,1)	63	(30,22,1)
30	(29,30,2)	64	(31,22,1)
31	(29,29,1)	65	(32,22,1)
32	(30,28,1)	66	(32,23,1)

Appendix M

Table 23 (Cont'd.)

IMAGINARY PARTICLE LOCATIONS FOR EXTRACTION SCENARIO NO. 8

Particle(s)	Model Cell (x,y,z)	Particle(s)	Model Cell (x,y,z)
33	(30,27,1)	67	(32,24,1)
34	(36,25,1)	68	(31,25,1)

Appendix M

Table 24

INPUT AND OUTPUT FILES FOR EXTRACTION SCENARIO NO. 8

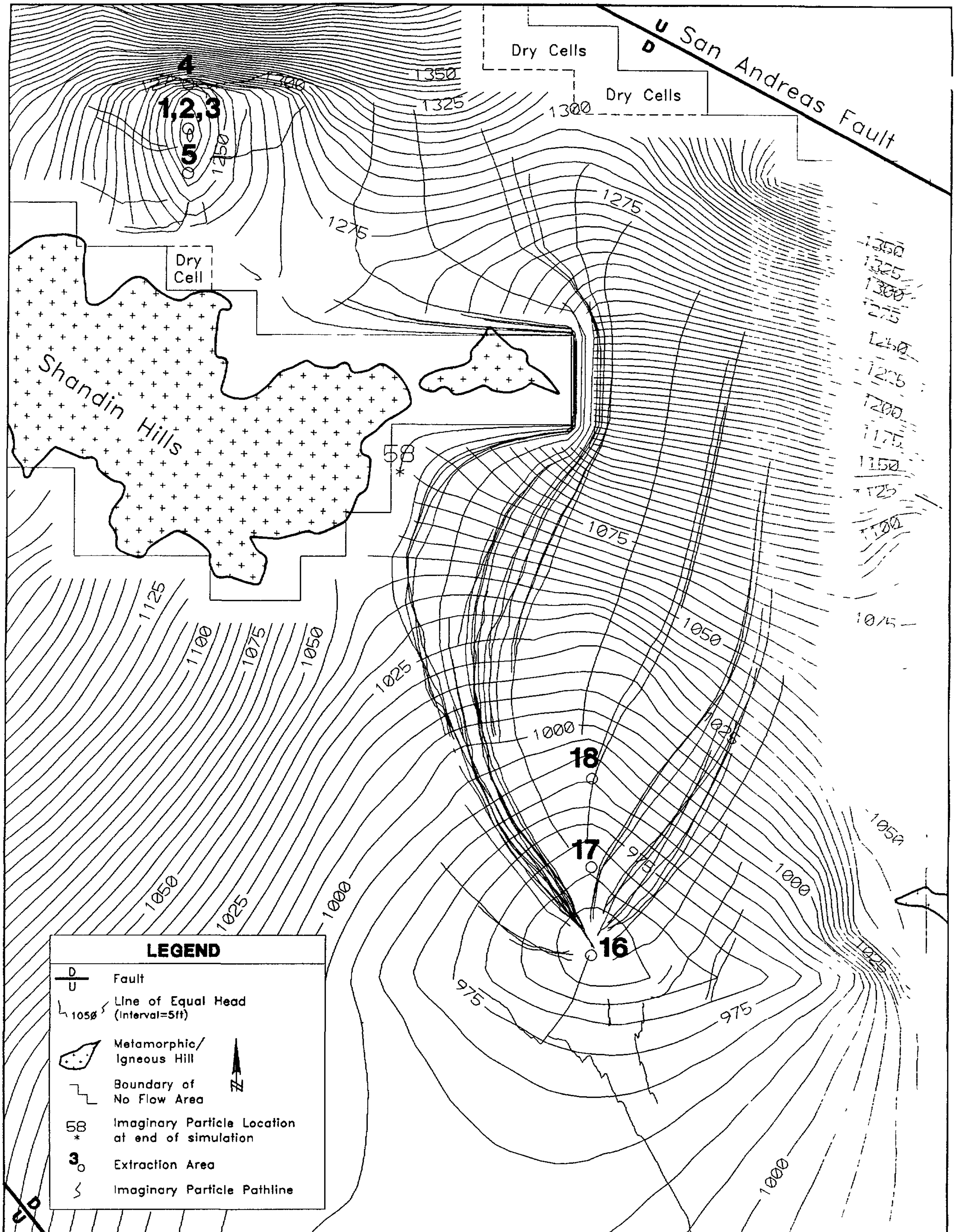
Run No.	Rootname Modification	Date	Extension	Filename	Type of File
39	B	07/24/92	BAS	34B0626.BAS	MODFLOW input file
39	B	07/24/92	BCF	34B0626.BCF	MODFLOW input file
39	B	07/24/92	OC	34B0626.OC	MODFLOW input file
39	B	07/24/92	PCG	34B0626.PCG	MODFLOW input file
39	B	07/24/92	RIV	34B0626.RIV	MODFLOW input file
39	B	07/24/92	WEL	34B0626.WEL	MODFLOW input file
39	B	07/24/92	GHB	34B0626.GHB	MODFLOW input file
39	B	07/24/92	EVT	34B0626.EVT	MODFLOW input file
39	B	07/24/92	BCF	34BCELL.BCF	MODFLOW cell-by-cell flow file
39	B	07/24/92	RIV	34BCELL.RIV	MODFLOW cell-by-cell flow file
39	B	07/24/92	WEL	34BCELL.WEL	MODFLOW cell-by-cell flow file
39	B	07/24/92	GHB	34BCELL.GHB	MODFLOW cell-by-cell flow file
39	B	07/24/92	EVT	34BCELL.EVT	MODFLOW cell-by-cell flow file
39	B	07/24/92	OUT	34B0626.OUT	MODFLOW output file
39	B	07/24/92	UFM	34BHEAD.UFM	MODFLOW unformatted head file
39	B	07/24/92	INP	34BPATH.INP	PATH3D input file
39	B	07/24/92	OUT	34BPATH.OUT	PATH3D output file
39	B	07/24/92	DAT	P3DCNFG.DAT	PATH3D data file
39	B	07/24/92	DAT	P3DPLOT.DAT	PATH3D data file
39	B	07/24/92	DAT	P3DFRONT.DAT	PATH3D data file
39	B	07/24/92	DAT	P3DCAPT.DAT	PATH3D data file
39	B	07/24/92	DAT	FRONTXYZ.DAT	PATH3D data file used with SURFER
39	B	07/24/92	DAT	PATHXYZ.DAT	PATH3D data file used with SURFER
39	B	07/24/92	BLN	PATHXY.BLN	PATH3D data file used with SURFER
39	B	07/24/92	BLN	PATHXZ.BLN	PATH3D data file used with SURFER
39	B	07/24/92	BLN	PATHYZ.BLN	PATH3D data file used with SURFER
39	B	07/24/92	GRD	34BCNTR1.GRD	SURFER grid file of head contours
39	B	07/24/92	GRD	34BCNTR2.GRD	SURFER grid file of head contours
39	B	07/24/92	PLT	34BCNTR1.PLT	SURFER plot file of head contours

Appendix M

Table 24 (Cont'd.)

INPUT AND OUTPUT FILES FOR EXTRACTION SCENARIO NO. 8

Rootname Run No.	 Modification	 Date	Extension	Filename	Type of File
39	B	07/24/92	PLT	34BCNTR2.PLT	SURFER plot file of head contours
39	B	07/24/92	DAT	XTRWL39B.DAT	Data file containing locations of extraction wells



URS CONSULTANTS
2710 GATEWAY OAKS DR.
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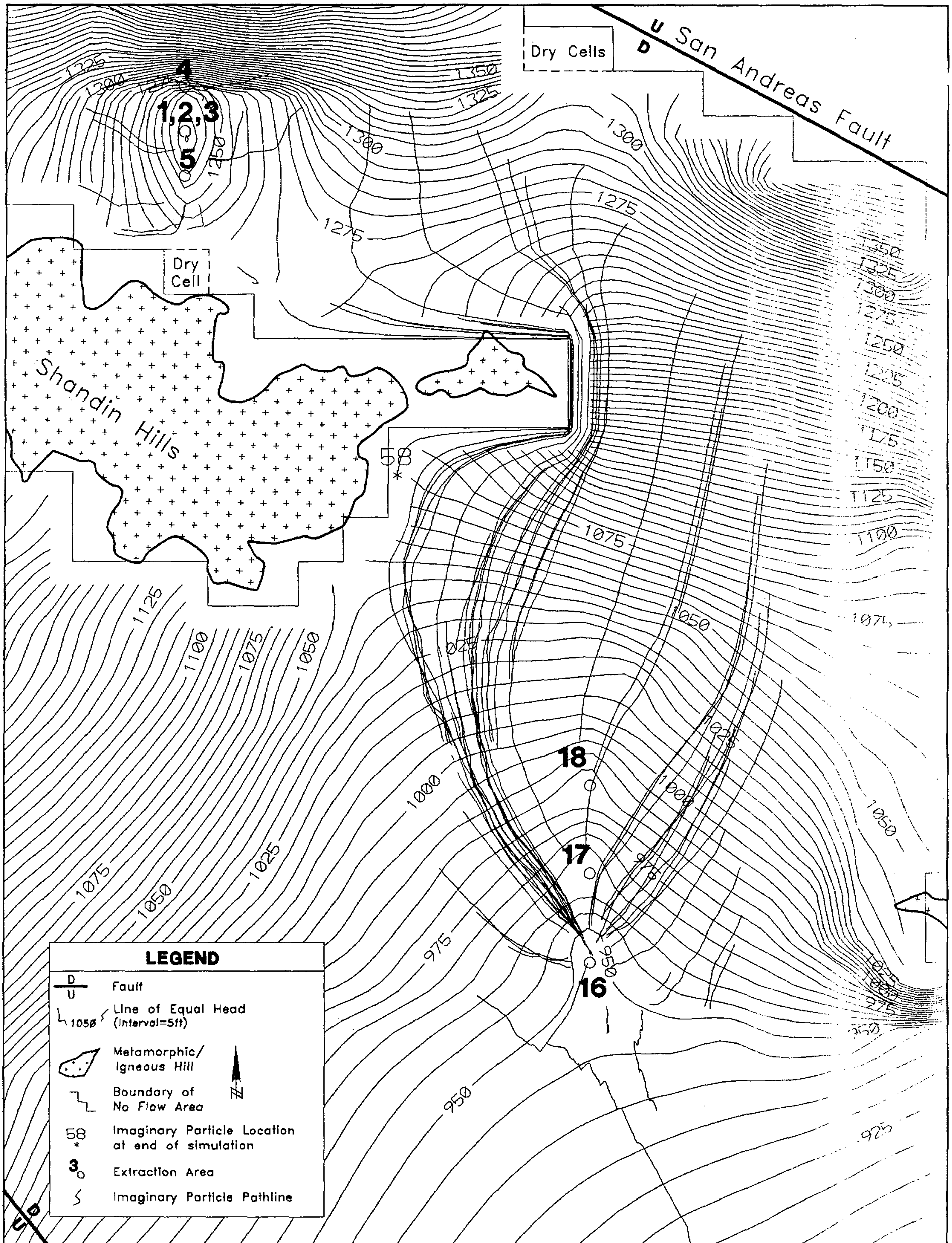
NEWMARK GROUNDWATER SUPERFUND SITE, NEWMARK OPERABLE UNIT RI/FS REPORT
ARCS, EPA REGIONS IX & X   WA NO 64-10-9LJ6

FIGURE 16
HEAD CONTOUR AND PATHLINE PLOT FOR EXTRACTION SCENARIO NO. 8, LAYER 1 (UPPER AQUIFER)

0 1000 2000
SCALE IN FEET



URS CONSULTANTS
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NEWMARK GROUNDWATER SUPERFUND SITE, NEWMARK OPERABLE UNIT
RI/FS REPORT
ARCS, EPA REGIONS IX & X WA NO. 54-10-9LJ5

FIGURE 17
HEAD CONTOUR AND PATHLINE PLOT FOR EXTRACTION SCENARIO NO. 8, LAYER 2 (LOWER AQUIFER)

0' 1000 2000'
SCALE IN FEET

This pumping scenario caused cells in layer 1 (the upper aquifer) to go dry in the Newmark plume area next to Shandin Hills. Additionally, no imaginary particles were being captured by the extraction areas located in the dry cell area (extraction area nos. 19 and 20).

- In the final simulation (Run 39B0724), extraction area nos. 19 and 20 were eliminated from the centerline extraction areas and five extraction areas were added in the Newmark wellfield. For the centerline extraction areas, extraction area no. 16 pumped at 4000 gpm and extraction area nos. 17 and 18 pumped at 3000 gpm each.

  For the five extraction areas in the Newmark wellfield, the four Newmark wells were used and extraction area no. 5 that was placed approximately 820 feet south of the Newmark wells. The four Newmark wells were pumped at their normal rates for January 1986 through December 1990 and extraction area no. 5 was pumped at 800 gpm;

- Sixty-seven of the sixty-eight imaginary particles were captured. Seven of the imaginary particles placed on the southeastern downgradient edge of the Newmark plume were not pulled towards and captured by the centerline extraction areas. These seven imaginary particles migrated towards the south/southeast. One of these seven imaginary particles migrated southeast and out of the model area (Figures 16 and 17). The other six imaginary particles were captured by existing water-supply wells; 17th Street well, 16th Street well, 7th Street well and Gilbert Street well; and

- The pumping scenario described above produced a capture zone in layer 1 that extended approximately 1.0 mile downgradient from the south edge of the Newmark plume. The capture zone produced for layer 2 (the lower aquifer) did no grow fast enough to capture the downgradient edge of the Newmark plume. It was concluded that the pumping rate for extraction area no. 16 would need to be increased to 6000 gpm or greater in order to have an affect on the downgradient edge of the Newmark plume. Another possibility would be to move the extraction areas just outside the downgradient edge of the Newmark plume and not increase the pumping rates. However, this pumping scenario would be very similar to the extraction area specifications used in extraction scenario no. 5.

12.0 EXTRACTION SCENARIO NO. 9

12.1 Objectives

The objectives for extraction scenario no. 9 were:

- Estimate the position of the Newmark plume 35 years from January 1986;
- Determine if any existing water-supply wells within the Newmark plume have an influence on the Newmark plume and could be utilized as possible extractions areas for the Newmark plume;
- Calculate groundwater velocities for three areas of the Newmark plume; and
- Estimate the time required to remediate the Newmark plume.

12.2 Procedure and Data

No prior simulations were made before the optimum simulation (Run 37A0716) was achieved for extraction scenario no. 9. The procedure described below was followed for achieving optimum Run 37A0716:

- Run 37A0716 was made using MODFLOW that ran for a time span of 35 years. The transient-state flow model, simulated and calibrated for the time period between January 1986 to December 1990, was used as the basis for Run 37A0716. The input data (including the well pumpage), and boundary conditions used in the calibration of the transient-state flow model, were applied to Run 37A0716 for the first five years of the simulation and repeated in 5-year intervals for 30 additional years. The input data and boundary conditions are described in more detail in Section 3.0;
- Extraction scenario no. 9 was a "no action" scenario where no extraction areas were added to the well input file. The quarterly pumping schedules for the existing water-supply wells, which were

pumping between January 1986 through December 1990, were used in repetitive 5-year intervals through 35-year simulation. Table 11 in Appendix J gives the locations of the existing water-supply wells and their pumping rates for the last quarter of 1990 (October through December) used in the simulation;

- PATH3D was applied to MODFLOW input data, output and the unformatted head files for Run 37A0716. A grid file of the heads was created through the application of PATH3D. Also, pathlines were created for three sets of imaginary particles that totalled 50 imaginary particles. Set 1 contained six imaginary particles that were placed upgradient to the Newmark wells in a north/south oriented line. Set 2 contained seven imaginary particles that were placed approximately half-way between the Newmark wells and the middle area of the Newmark plume, in a north/south oriented line. Set 3 contained 37 imaginary particles that were placed along the outer perimeter of the bottom two-thirds of the Newmark plume. Table 25 gives the locations of the imaginary particles; and

- SURFER was used to produce plots of the head contours and pathlines created during the application of PATH3D.

12.3 Results and Summary

The head contour plots for layers 1 and 2 (37ACNTR1.PLT and 37ACNTR2.PLT) and the PATH3D output file for Run 37A0716 were analyzed. Figures 18 and 19 display the head contour plots for layers 1 and 2, respectively. These figures also display the extraction areas, and imaginary particles with their pathlines. Table 26 lists the MODFLOW, PATH3D and SURFER files associated with Run 37A0716. The results and summary of the analysis are listed below:

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Table 25

IMAGINARY PARTICLE LOCATIONS FOR EXTRACTION SCENARIO NO. 9

Particle(s)	Model Cell (x,y,z)	Particle(s)	Model Cell (x,y,z)
1	(31,26,1)	20	(34,37,2)
2	(32,26,1)	21	(33,28,2)
3	(33,26,1)	22	(32,38,2)
4	(34,26,1)	23	(31,38,2)
5	(35,26,1)	24	(30,37,2)
6	(36,26,1)	25	(30,36,2)
7	(36,27,1)	26	(29,35,2)
8	(36,28,1)	27	(29,34,2)
9	(36,27,1)	28	(29,33,2)
10	(36,30,1)	29	(29,32,1)
11	(36,30,2)	30	(29,32,2)
12	(35,31,1)	31	(29,31,1)
13	(35,31,2)	32	(29,31,2)
14	(35,32,1)	33	(29,30,1)
15	(35,32,2)	34	(29,30,2)
16	(35,33,2)	35	(29,29,1)
17	(35,34,2)	36	(30,28,1)
18	(35,35,2)	37	(30,27,1)
19	(35,36,2)		
Set 2			
38	(22,17,1)	41	(21,19,1)
39	(21,17,1)	42	(21,20,1)
40	(21,18,1)	43	(22,20,1)
Set 3			
44	(28,17,1)	48	(27,20,1)
45	(27,17,1)	49	(27,21,1)
46	(27,18,1)	50	(27,22,1)
47	(27,19,1)		

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Table 26

INPUT AND OUTPUT FILES FOR EXTRACTION SCENARIO NO. 9

Run No.	Rootname Modification	Date	Extension	Filename	Type of File
37	A	07/16/92	BAS	34B0626.BAS	MODFLOW input file
37	A	07/16/92	BCF	34B0626.BCF	MODFLOW input file
37	A	07/16/92	OC	34B0626.OC	MODFLOW input file
37	A	07/16/92	PCG	34B0626.PCG	MODFLOW input file
37	A	07/16/92	RIV	34B0626.RIV	MODFLOW input file
37	A	07/16/92	WEL	34B0626.WEL	MODFLOW input file
37	A	07/16/92	GHB	34B0626.GHB	MODFLOW input file
37	A	07/16/92	EVT	34B0626.EVT	MODFLOW input file
37	A	07/16/92	BCF	34BCELL.BCF	MODFLOW cell-by-cell flow file
37	A	07/16/92	RIV	34BCELL.RIV	MODFLOW cell-by-cell flow file
37	A	07/16/92	WEL	34BCELL.WEL	MODFLOW cell-by-cell flow file
37	A	07/16/92	GHB	34BCELL.GHB	MODFLOW cell-by-cell flow file
37	A	07/16/92	EVT	34BCELL.EVT	MODFLOW cell-by-cell flow file
37	A	07/16/92	OUT	34B0626.OUT	MODFLOW output file
37	A	07/16/92	UFM	34BHEAD.UFM	MODFLOW unformatted head file
37	A	07/16/92	INP	34BPATH.INP	PATH3D input file
37	A	07/16/92	OUT	34BPATH.OUT	PATH3D output file
37	A	07/16/92	DAT	P3DCNFG.DAT	PATH3D data file
37	A	07/16/92	DAT	P3DPLOT.DAT	PATH3D data file
37	A	07/16/92	DAT	P3DFRONT.DAT	PATH3D data file
37	A	07/16/92	DAT	P3DCAPT.DAT	PATH3D data file
37	A	07/16/92	DAT	FRONTXYZ.DAT	PATH3D data file used with SURFER
37	A	07/16/92	DAT	PATHXYZ.DAT	PATH3D data file used with SURFER
37	A	07/16/92	BLN	PATHXY.BLN	PATH3D data file used with SURFER
37	A	07/16/92	BLN	PATHXZ.BLN	PATH3D data file used with SURFER
37	A	07/16/92	BLN	PATHYZ.BLN	PATH3D data file used with SURFER
37	A	07/16/92	GRD	34BCNTR1.GRD	SURFER grid file of head contours
37	A	07/16/92	GRD	34BCNTR2.GRD	SURFER grid file of head contours
37	A	07/16/92	PLT	34BCNTR1.PLT	SURFER plot file of head contours

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Table 26 (Cont'd.)

INPUT AND OUTPUT FILES FOR EXTRACTION SCENARIO NO. 9

Run No.	Rootname Modification	Date	Extension	Filename	Type of File
37	A	07/16/92	PLT	34BCNTR2.PLT	SURFER plot file of head contours
37	A	07/16/92	DAT	XTRWL37A.DAT	Data file containing locations of extraction wells

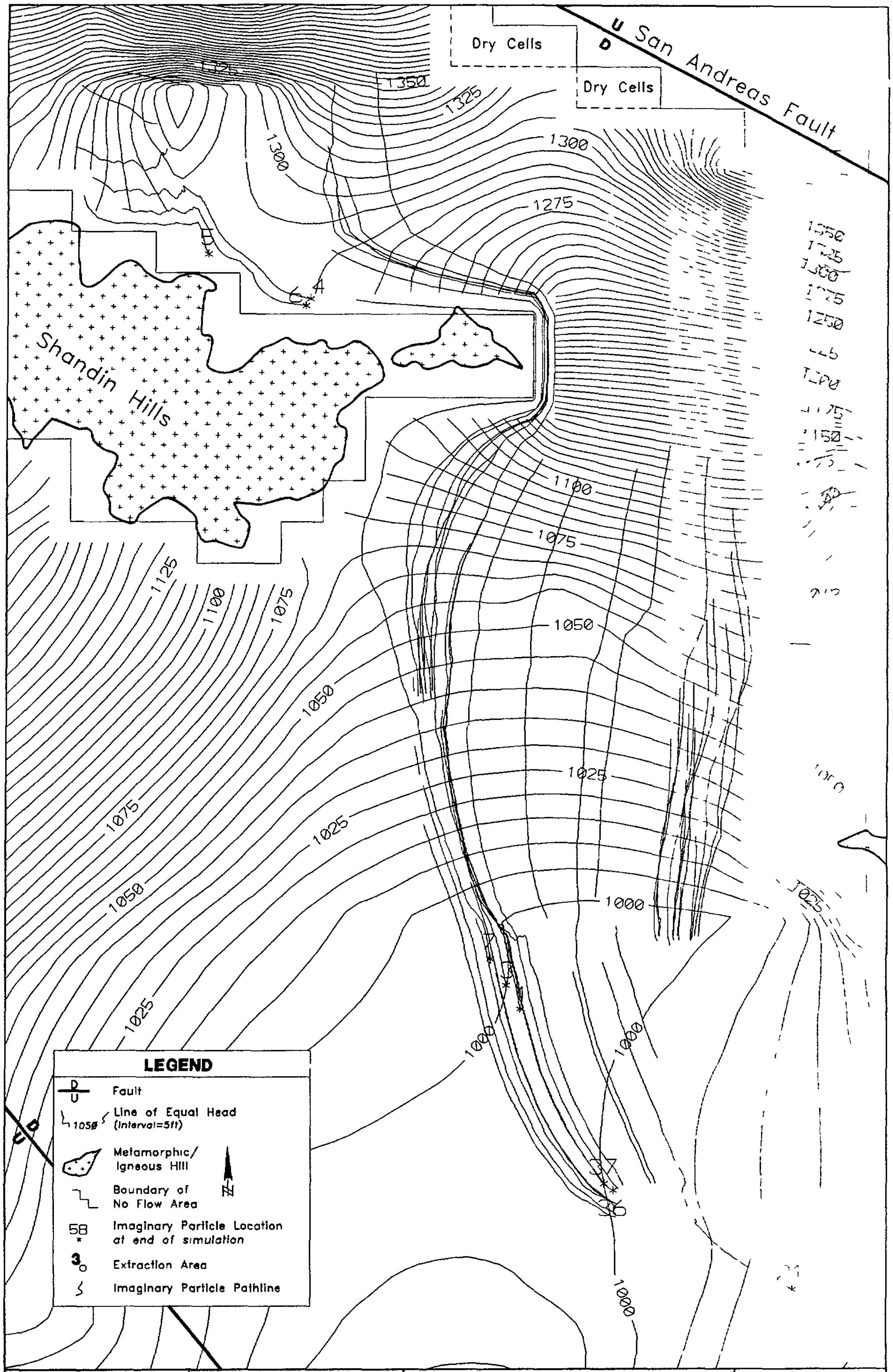

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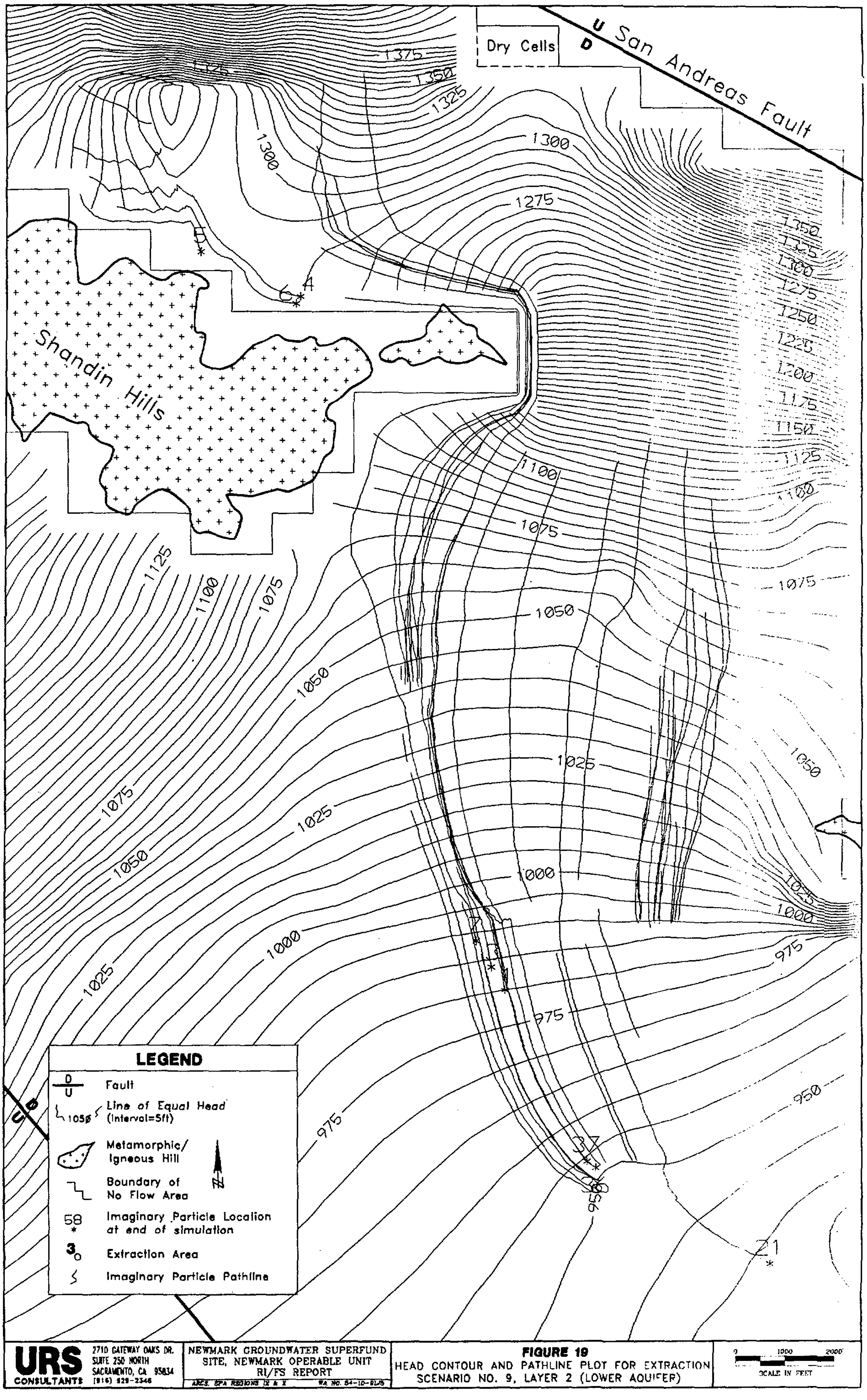
FIGURE 18
HEAD CONTOUR AND PATHLINE PLOT FOR EXTRACTION SCENARIO NO 9 LAYER 1 (UPPER AQUIFER)

0 1000 2000
SCALE IN FEET


Dry Cells
U
D
San Andreas Fault
Shandin Hills
1375
1350
1325
1300
1275
1250
1225
1200
1175
1150
1125
1100
1075
1050
1025
1000
975
950
LEGEND
Fault
Line of Equal Head (Interval=5ft)
Metamorphic/ Igneous Hill
Boundary of No Flow Area
Imaginary Particle Location at end of simulation
Extraction Area
Imaginary Particle Pathline
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ARCS, EPA REGIONS IX & X
WA NO. 54-10-9LJ9
FIGURE 19
HEAD CONTOUR AND PATHLINE PLOT FOR EXTRACTION SCENARIO NO. 9, LAYER 2 (LOWER AQUIFER)
0
1000
2000
SCALE IN FEET

- The imaginary particles for set 1 migrated in the southeast direction toward a field of several water-supply wells. This well field was located approximately 2.0 miles southeast of the estimated downgradient edge of the Newmark plume, in the general area of cells (37,45) and (37,46). The wells in this field were Antil wells no. 2 through 6 (City of San Bernardino), Schueuer (City of Riverside), Garner wells no. 1, 2, 4 and 5 (City of Riverside), and East Valley Water District wells no. PL 11A and 12A;

  Based on the results of the "no action" scenario, the imaginary particles for set 1 are migrating towards the wellfield described above. However, it is not known at this time if the portion of the Newmark plume represented by the set 1 imaginary particles would be totally captured by the wellfield. Also, at this time, it is difficult to determine when the set 1 imaginary particles would reach the downgradient wellfield. Furthermore, since the wellfield described above is located at the eastern edge of the model area, the model area would need to be widened in order to simulate the future movement of the Newmark plume near this wellfield;

- At the present time the Newmark plume, based on the position shown on the Upper Santa Ana Basin - Well Map (NBS/Lowry Engineers and Planners), is approximately 12,500 feet (2.4 miles) long measured from the northeast edge of Shandin Hills. It is approximately 6000 feet (1.1 miles) wide adjacent to the southeast edge of Shandin Hills. Based on the positions of the imaginary particles, the extent of the Newmark plume will be approximately 20,000 feet (3.8 miles) long from the northeast edge of Shandin Hills after 35 years of migration. It will span approximately 6500 feet (1.2 miles), at its widest point adjacent to the southeast edge of Shandin Hills. Therefore, according to the results of the project flow model, the Newmark plume will migrate approximately 7500 feet (1.4 miles) downgradient and widen approximately 500 feet in 35 years;

- Existing water-supply wells within the Newmark plume that captured imaginary particles in the "no action" scenario and that may have an influence on the Newmark plume are:

  1) The North E Street and 27th Street wells captured particles on the westside of the Newmark plume (southeast edge of Shandin Hills);

2) The 23rd Street well also captured particles on the westside of the Newmark plume;

3) The 16th and 17th Street wells captured particles in the center of the Newmark plume just approximately 2000 feet north of the extraction areas located at the downgradient edge of the Newmark plume;

4) The Gilbert St. well captured particles located in the southeast portion of the Newmark plume; and

5) The North E Street, 27th Street and 23rd Street wells contained very small amounts of contamination during the latest sampling. The 16th and 17th Street wells had slightly higher concentrations of contaminants. The Gilbert Street well has had no detectable contamination to date. The model predicts the Newmark plume edge will reach the Gilbert Street well in approximately three years from 1992. Other existing water-supply wells within the Newmark plume were not actively pumping during the base period of the simulation and their influence was not simulated during this model run.

- Groundwater velocities were calculated for three areas of the Newmark plume: the Newmark wellfield, the middle area and the lower two-thirds area. The groundwater velocities were represented by the velocities of the imaginary particles that were placed in three areas of the Newmark plume. The velocity of a imaginary particle equals the travel-distance divided by the travel-time. Imaginary particles that were not affected by the boundary conditions of the project flow model, and plotting limitations of SURFER and PATH3D, were used to determine average groundwater velocities for the three areas of the Newmark plume. The limitations of SURFER and PATH3D will be discussed in Section 15.2. Table 27 gives the average groundwater velocities calculated for the three areas of the Newmark plume.

The groundwater velocities determined for the three areas of the Newmark plume were averaged together to determine one average groundwater velocity for the Newmark plume area. All groundwater velocities for the three areas were weighted evenly in the calculation of the average groundwater velocity for the following reasons:

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Table 27

AVERAGE GROUNDWATER VELOCITIES FOR NEWMARK PLUME

Velocity (ft/day)	Velocity (ft/yr)
Newmark wellfield (Area 1)	
0.51	185.5
Middle Area (Area 2)	
1.57	573.6
Lower Two-thirds of Newmark Plume (Area 3)	
0.85	308.6
Average Groundwater Velocity	
0.98	355.9

- The project flow model is a computer model and, therefore, the groundwater velocities given by the project flow model are estimates or averages. Therefore, enough rationale could not be found to weigh one of the velocity values of a specific area more than the others.

- It is not known how the groundwater velocities, estimated for the three areas of the Newmark plume, compare with field conditions since measured groundwater velocities for the Newmark plume area do not exist. Therefore, it was decided not to weigh one of the velocities of a specific area more than the others.

- The lower two-thirds of the Newmark plume is an area where the project flow model was calibrated with more confidence. The water elevations calculated in this area matched the observed water elevations very well (see Sections 2.5 and 2.8 of Appendix J). (Since the average groundwater velocity (355.9 ft/yr) agrees very well with the estimated groundwater velocity for the lower two-thirds of the Newmark plume (308.6 ft/yr.) It is concluded that the average groundwater velocity of 355.9 ft/yr is the best value available at this particular point of the modeling study.

The time required to remediate the Newmark plume will be estimated using the average groundwater velocity for the Newmark plume area and the total centerline distance of the Newmark plume measured from the Newmark wellfield to the downgradient edge. This calculation will be described in Section 14. Figure 20 displays the Newmark plume divided into the three areas and the Newmark plume centerline.

13.0 VELOCITIES OF TCE AND PCE IN THE GROUNDWATER

The velocities of TCE and PCE in the groundwater will be estimated in this section. The parameters and properties necessary to calculate the site specific velocities for TCE and PCE in the groundwater include these characteristics of the groundwater, soil medium and TCE and PCE:

- Groundwater velocity.
- Porosity of the soil medium.
- Soil bulk density.
- Organic carbon content of the soil medium (f_{oc}).
- Adsorption or distribution coefficient of an organic chemical between soil surfaces and water (K_d).

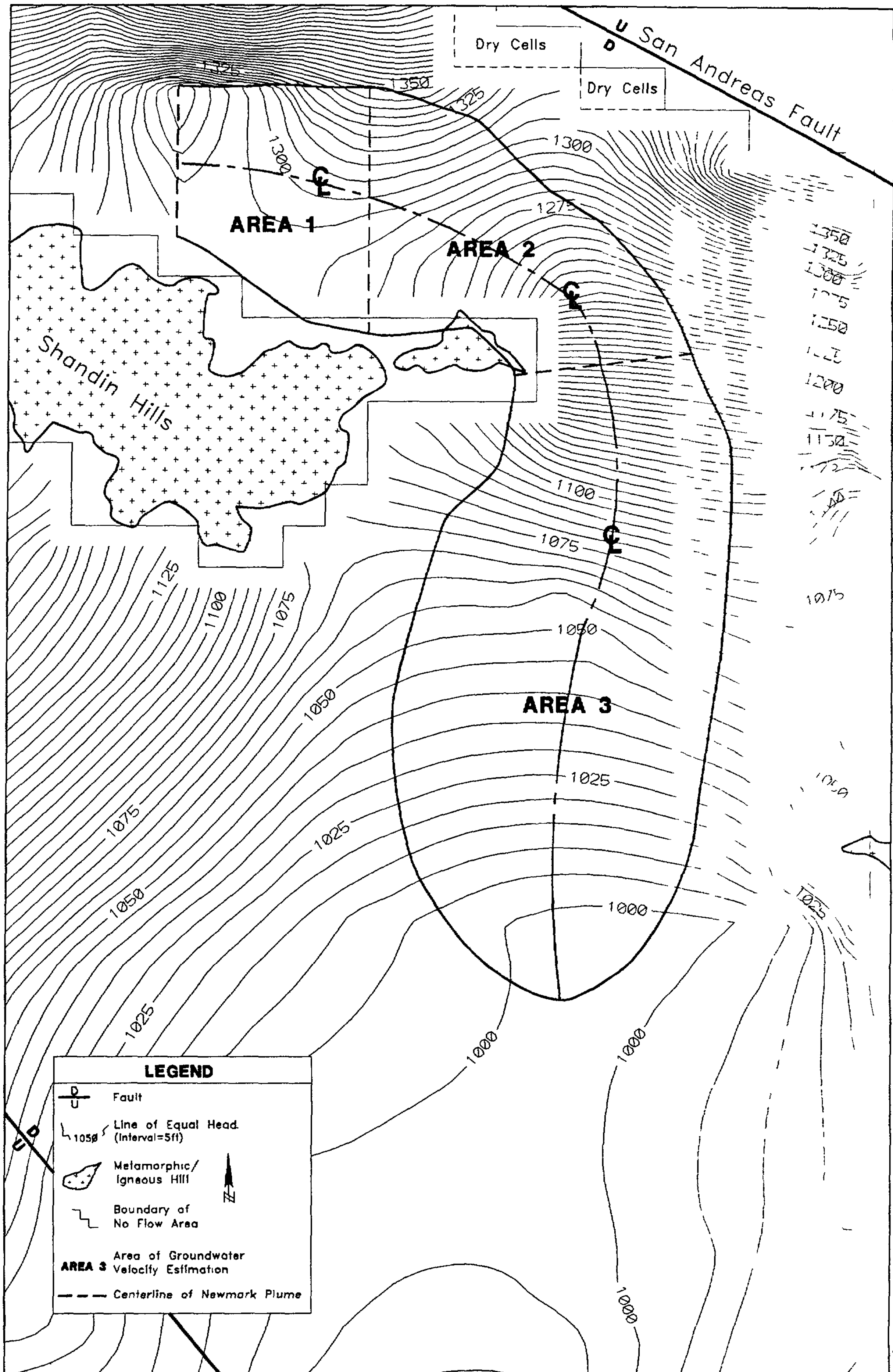

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FIGURE 20

LOCATIONS OF GROUNDWATER VELOCITY AREAS

0 1000 2000
SCALE IN FEET